Knowledge Management Activity in the Satellite domain in JAXA

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ABSTRACT

Previously, each satellite project in JAXA had its own way of managing technical information (e.g. technical documents for planning, requirements, specifications, design, test, operation, etc.) individually. There were no standard rules, including classification rules, among projects. Although there was an information shared environment in JAXA, each project didn't submit their own information actively due to lack of functions for proper access control and rapid acquisition of information. These situations made users very difficult to gather information on other projects, so that users were needed to share their knowledge mainly by face-to-face communications. Additionally, there was the risk of losing significant knowledge of satellite projects at the time of their termination.

In order to solve these issues, it was necessary to change the culture of managing technical information. Through long discussions with each project, minimum standard rules including user-friendly classification rules were established from the point of view of leveraging knowledge. A system with the function of appropriate access control was developed to implement the standard rules. Since April 2007, the rules and the system have been applied to each project. The risk of losing knowledge has been reduced by enabling the terminated projects to transfer their technical information to the system smoothly.

This paper presents an overview of our current knowledge management activity in the satellite domain including the remaining issues and the proposed solutions to these issues.

1. INTRODUCTION

1.1 Goal

One definition of the goal of knowledge management is "getting the right information to the right people at the right time, and helping people create knowledge and share ..." (NASA knowledge management team, 2002). Knowledge is called the fourth management property, and the importance is needless to say.

In JAXA, the satellite office has been seeking to improve the reliability of the space satellite. For that, assured transfer of technological knowledge is necessary. In particular, we think that "Promotion of leveraging" and "Prevention of losing" of the technical information are important for this achievement.

Through KM activities, the satellite office has been aiming at raising and developing the reliability of the space satellite of Japan to an international level.

1.2 Background

In 2004, it found that a lot of technical documents of the ADEOS-2 (Advanced Earth Observation Satellite 2) project that had already terminated left without being classified. The project members had moved to other projects and were engaged in new efforts. New personnel in charge of classifying the remaining technical documents had to decide the treatments without understanding which documents have the important knowledge in the contents of them, so the risk of losing important technical information of the project was of large concern.

In the background, each project manager was able to decide almost all parts of the method of project management. The management of the technical information was also done by each method. For examples, different categorization rule (person in charge, technical field, and the date) was done, and a different tools (HTML, Windows file sharing, CGI, and J2EE system) were used by each project. Some older projects didn't have a document management system. There was no standard rule among the projects. This is a kind of "culture".

We began investigating to understand detail current situation.

1.3 Issues

We interviewed the project member. As a result, two issues about technical information management were discovered. One was that sharing information among projects was inadequate. Another one is that there was the risk of losing technical knowledge of the terminated project.

The interview showed that the cause of the inadequate sharing information on another project is "walking by oneself information". "Walking by oneself information" means that the information transfers to someone without control, and sometimes transfers different meanings. Project members concerned that their information might be used by a person who didn't know the background of the information in the place that they didn't know. Moreover, there is an issue of the treatment of manufacturer's technical information. JAXA has loan employees from the satellite manufacturer. If the technical information was inspected by someone before project members know, it becomes a reliance issue between projects and the manufacturer.

For these reasons, sharing information was done by face-to-face communication, which has been a certain kind of culture of satellite projects. When project members provided their own information to the personnel of other department, they gave only necessary parts of the information after project members explains the background and the careful attention of usage. Face-to-face communication is very important, however the existence of information wasn't known until hearing form project member, and when the person is gone, the chance to get information will be lost.

> "Technology has to be married with face-to-face interaction to create the most effective systems; one does not replace the other, although clearly one can greatly enhance the other."(Nancy 5)

In the above-mentioned, it is necessary to combine communications of face-to-face and sharing with IT tools.

The interview also said that we had the risk of losing the technical information. A project is a temporary organization. So there was a possibility that a project would be terminated without classification of its technical information. The cause was the absence of any storage environments for terminated projects as well as any standard rule concerning capturing and storage.

There was no destination to store their technical information permanently. There was an environment to share technical information called "Digital ARChive system (DARC)" in JAXA. However the system didn't have an appropriate access control function. Even if it was sensitive information, the system allowed all JAXA personnel to access the information automatically. Moreover, because the interface of the retrieval was not the best for the project, it took time for the information acquisition. The policy of capture and storage of DARC was different from what the satellite office wanted to store. From those reasons, the project didn't resister their technical documents actively.

Because of lack of standard capture and storage rule, the following was happened. When the project is terminated, if the technical documents are classified with the project own criteria, some important documents would be disposed and some unimportant documents would be stored. When the project's own tool of documents management is removed, if there is not the storage rule, there is a possibility that the technical information managed with the tool would be lost. Such as ADEOS-2 project, in some cases where project members tend to classify technical documents at the end of project, they couldn't complete classification and left their information untouched.

Not all information is important. Storage of all information without classification increases costs of maintenances of the documents. In particular, paper documents need a lot of inventory location. Additionally, when the information is stored with classification which is also different from other projects, the information would become missing and it is not easy to retrieve it later.

This background which is the absence of standard rule and sharing environment had already taken root in the project member's thought, and was a kind of culture in the projects of satellite office. This paper will describe our challenges to solve these issues.

2, ACTIVITIES

In order to solve these issues, the following activities have been done.

- 2004: start this activities
- 2005: basic policy adjustment
- 2006: Make it a standard rule and the tool
- 2007: New operation is starting here

These activities are described below.

2.1 Scope

To prevent being expanded too much and failing our activities, we decided the scope of the knowledge which we would deal with.

The technical information consists of technical documents (such as documents of planning, requirements, specifications, design, test, operation, etc.) and technical data (such as data of analytical data and test data, etc.). As a first step, our target was “technical document” captured by projects. The improvement of managing technical documents was required especially.

2.2 Basic Policy

To solve the issues, we tried to change the culture. As a chance of the change, in order to transfer the will of the satellite office to the project member, the basic policy was discussed including the project manager and the director. As a result, the basic policy was decided as follows.

- Fundamental action

Project members usually have to create technical information while considering sharing it with others. For sharing with other people, project members have to make the rationale clear.

- Sharing all technical documents (at least their existence)

Project members have to share all their technical documents. However in consideration of the issue of “walking by oneself information", on-going projects are allowed to submit only the existence (meta-information) of the information. This was a compromise between sharing and protecting information such as not finalized information and proprietary information..

- Standard categorization rule

Projects have to not use their original categorization rules but the standard rule for the improvement of the retrieval.

- Responsibility of leveraging

The information users have responsibility for the leverage. When an accident happens because of the use of information, not the person who provides information but the person who uses information is responsible.

- Assured transfer

To prevent losing technical documents, project members have to transfer their important technical documents to other departments assuredly until the project terminates.

- Computerized documents

As a rule, the capture and storage of the technical documents have to be made not on paper but as an electronic file in consideration of the easiness of the retrieval, sharing, and maintenance.

Table 1
Standard category and definition of contents and priority

Standard category	Definition of contents	Priority[a]
Plan & Management	Project Planning document	*
	Configuration Management document	*
	…	
Engineering Specification	System Development specification	*
	Mission Requirement document	*
	Interface Control Specification	*
	…	
Design Review	Report of the System Requirements Review	*
	Report of the Preliminary Design Review	*
	Input package of Critical Design Review	
	…	
…	…	…
Contract	Procuration specification	*
	Quotation	
…	…	…
Meeting Materials		
Etc.		

[a] The documents with asterisk'*' are high priority documents.

2.3 Standard Rule

In order to archive a basic policy, and to indicate what to do to the project members specifically, the minimum standard rule was established. The following rules were decided through a long discussion with the project members. We think that continuous examinations and reflections of this rule to the future are necessary.

- Preparation at project start
- Capture
- Storage
- Leverage
- Arrangement when project terminates

(1)Discussion with project

The three most important discussion points were the following concerning "How to leverage information".

- In what case do you use technical documents?
- What documents do you use in those cases?

Examples of the discussion are shown as follows. "We use the mission requirement document, when preparing starting up a project". "We use the report of design review, when preparing the design review board".

- What is the easiest categorization of documents to retrieve?

As each person has different viewpoint of categorization, a perfect categorization that can satisfy everyone is impossible.

The result of the discussion is reflected in a definition and a standard categorization of contents shown next.

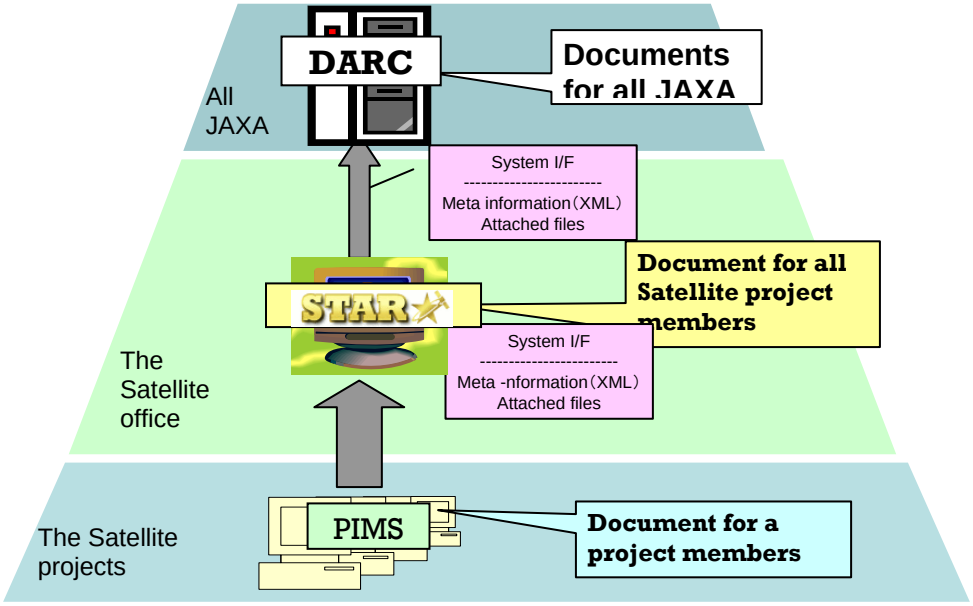

Fig 1 Three Layer Structure

(2)Definition of contents

It is very important to understand what knowledge exists in starting the knowledge management. Otherwise, it is not possible to discuss with the same standpoint as the project members.

From the result of the discussion and the investigation, the contents which the satellite projects create as technical documents were defined. Some documents are useful inside on-going projects but not useful for other projects. (e.g. Daily meeting materials in progress, daily work reports, etc.) Therefore, in order to make it clear what the important documents are, the priority of the documents is defined based on the result of the discussion. (Table 1)

(3)Standard category

From the result of the discussion and the investigation, standard category was defined in order to make it possible for users to retrieve documents easily with the same idea of categorization. (Table1) This category was defined based on mainly the phase of satellite development such as planning, requirements, design, manufacture, test, launch, operation and application.

Each project has peculiar documents, so this category is a rough level. If necessary, projects can define category in more detail.

(4)Others

Some important points of a concrete procedure concerning other rules are as follows.

- How to prepare when project start up
- How to leave the rationale of information on the technical documents
- How to computerize documents
- How to leverage information with responsibility

- How to transfer assuredly to other departments when a project is terminated.

2.4 Tools

By using IT tools, an environment that can achieve a standard rule was constructed.

(1)Whole architecture

Whole architecture is presented in fig.1. It consists of a three layer structure, and it connects by interfaces between systems that use the XML technology. (Fig. 1)

- All JAXA Layer

This layer is for the management of documents for all JAXA, and DARC is in the layer. DARC is the existing system that manages all company documents and is managing not only the electronic file but also location of the paper documents. When the technical documents are registered, the electronic file is shared in all JAXA.

- The Satellite office Layer

This layer is for sharing information between the projects in the satellite office. Satellite Technical information ARchive system (STAR) that we developed for breakthrough of situation is in the layer. Detailed information will be described.

- The Projects Layer

This layer is for sharing information inside the project, and Project Information Management System (PIMS) is in the layer. PIMS is an open source system that is becoming a de facto standard for projects in the satellite office. The projects maintain the PIMS by themselves and devise the method of technical information management by using the system. The function of access control is only “Basic Authentication” provided from the web server but it is enough to use in a project.

The reason for the three layer architecture will be described as follows.

First, the policy of the contents collections of DARC was different from the satellite office. The policy of DARC couldn’t cover all the technical documents required in the satellite office.

Second, the function of access control required from the satellite projects was not able to be implemented to DARC. Because DARC was for all department of JAXA, the function was not able to be changed easily by the demand from only the satellite office.

Third, the termination of the project was scheduled for the very near future, so it was necessary to speed up the system construction that became the destination of the project’s technical documents’ storage.

Lastly, it was impossible to open PIMS to other projects and share the information because the functions were for only inside project sharing and there was a culture which project members feel opposition to open their own information freely.

For these reasons, we decided to introduce STAR between DARC and PIMS which had already existed, and it became the three layers architecture shown in Fig.1.

(2)Feature of STAR

- Access control

Although all the people who can login to this system are able to see the meta-information, and find the existence of information, the electronic file cannot be downloaded except by the permitted person. STAR is able to control access to each document, as above.

- Approval application for downloading

This is a function to prevent “walking by oneself information”. A person who cannot

download a technical document which he or she wants to use can submit “approval application” for the document. The administrator of the technical document can permit or reject the application with comments. If the approval application is permitted, the person who submits application can download the file. As above, the document administrators can prevent their projects’ own documents from being used freely.

- Three functions of retrieval

STAR is the system for leverage of information, so we have been concentrating the retrieval functions. Therefore STAR has three functions of retrieval. One is the matrix retrieval that users can retrieve information by checking at the points where “satellite” as column, and “standard category” as low cross. Another one is the tree retrieval that users can narrow down information by using the category of tree structure. The last one is the meta-retrieval that users can retrieve information by setting some meta-information.

- Interface between systems

Information between each system (Between PIMS-STAR and between STAR-DARC) can be copied by one click. Previously, users had to register the technical documents to both PIMS and DARC. By using the interface function, those duplicate registrations can be avoided. The interface file is composed of meta-information (XML) and the electronic file.

3. RESULT

Since April 2007, the rules and the system have been applied to each project. The most important point is that the culture is changing. Previously the project members were sharing information only inside of project. Recently they are becoming to share information among projects in the satellite office by using STAR.

3.1 Rule

(1) Applying standard category

A standard category was applied to PIMS within the range possible for each project. A project applied the idea of standard category to not only PIMS but also the folder structure of Windows file sharing. The projects in the satellite office are beginning management according to the standard rule. It can be expected to become easier to retrieve technical documents by using the same idea of category in STAR, PIMS and Windows file sharing. The fact that most projects are beginning to use PIMS also makes it easy to apply the standard category.

(2) Smooth Project termination

In April and May, 2007, two satellite projects (Optical Inter-orbit Communications Engineering Test Satellite (OICETS) and Advanced Land Observing Satellite (ALOS)) were terminated smoothly after transferring the important technical documents (high priority documents) to the operation division according to the standard rule, and disposing of unnecessary documents (low priority documents). The transferred technical documents were registered to STAR. This means that the standard rule prevented the technical information from being lost.

3.2 Tool

STAR just still started running. It is necessary to assess how STAR contributes to the assured transfer of technological knowledge, and to the improvement of the reliability of the satellite development.

(1)The stream of information started

From May 2007, the stream of information between the systems shown in Fig. 1 has also started. PIMS's becoming de facto standard contributes to this stream. The information's gathering from PIMS in STAR has two meanings as follows.

One is that project members can share the technical information which previously they were able to share only by face-to-face communication. The users of STAR can retrieve necessary technical information very quickly, by using three retrieval functions, and at least come to know the existence of the technical documents.

Another one is that STAR can prevent losing important technical information by storing to this system, even if PIMS was removed when the project terminated. Before the project is terminated, the project member will transfer the necessary technical documents to STAR by using the interface between systems.

(2)New registration notification started

STAR is not only waiting for user's access, but also notifies users of the new information which was registered the day before. The function had started in June 2007, which is two month after from starting STAR. As the result, the number of users' login to the system increased more than twice number of users' login before.

4. REMAINING ISSUES

The capture of technical information has progressed. However some issues still remain in the part concerning leverage.

4.1 Slow growth of using STAR

At the present moment, the number of times STAR is used is less than predicted. If STAR was not used, of course there will be less effect of sharing information. It is thought that the leverage is going into the bad spiral due to less information shown in Fig. 2.

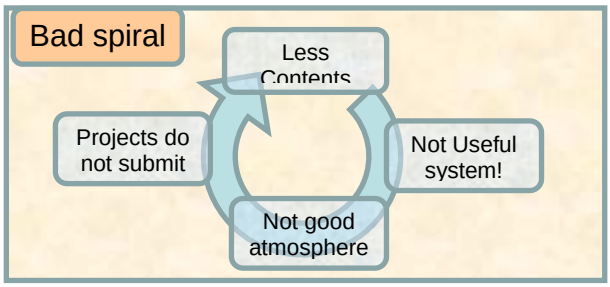

Fig 2 Bad spiral for technical information leverage

This means as follows. The quantity of contents in STAR is small, so the system will be getting less useful. The atmosphere will be getting worse, and the reputation of STAR will decline among project members. The reputation will disturb the submission of the projects' technical information. That will keep the contents of STAR old and the situation which the quantity of contents is small will continue.

4.2 Increasing access limited documents

The number of access limited documents is larger than predicted. Of course it is better to share the contents of information rather than only the existence of it. However the function for sharing the existence prevents sharing the contents. Some project members still think that they should share information only face-to-face and should not inspect freely. This is a remaining cultural issue.

4.3 Lack of technical information of other departments.

STAR has Technical information that is captured in the satellite office only, so it

doesn't have technical information of other departments. The technical information of other departments shown as follows is necessary for project members to promote projects.

- Failure information system managed by Safety and Mission Assurance Department
- Test data management system managed by Environmental and Structural Test Laboratory
- Parts database managed by Mechanical Components and Materials Engineering Group

When project members want to use these databases of other departments, they have to retrieve each system.

4.4 Imperfect retrieve functions

Though STAR has three retrieve functions, it cannot satisfy all users' requirement to retrieve. STAR has not been implemented yet to retrieve functions required by users based on such as satellite structure, work brunch structure, document tree and so on. In order to realize their retrieve functions, the process to add additional information such as keywords to the technical information have to be defined. However we are considering it and have not decided it yet. Trade-off is necessary between the intuitive retrieval and the workload to add additional information.

4.5 A lot of server machines

In consideration of End User Computing (EUC), projects themselves have been promoting the introduction of information technology. Projects have responsibility for the maintenance and operation of PIMS. Therefore each project has its own server machine. There are so many server machines, that it costs a lot for projects.

5. FUTURE WORK

5.1 near-term

The near-term future works which we are preparing now are described here. It is important to change the situation of leverage to a good spiral shown in Fig. 3.

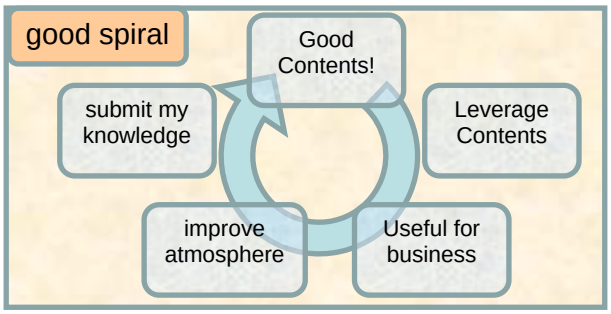

Fig 3 Good spiral for technical information leverage

The hopeful spiral is as follows. First the quantity and quality of contents in STAR is improved. Project members leverage those contents and feel it useful for their business. The project members develop a good reputation for STAR, and the atmosphere is improved. So the project members submit their own technical information actively. The latest technical information is submitted, and the contents of STAR become enriched.

(1)Enrichment of Contents

By increasing contents which project members require and by correcting contents which are found including incorrectly registered information, we will improve the quality and the quantity of contents.

In order to realize these, it is necessary for the administrators who are promoting leverage and managing STAR to understand what technical information exists and have a policy of how to leverage that information.

"Category and contents and priority" in the standard rule should be continuously kept improving.

This activity will promote the usage of STAR and the leverage of technical information.

(2) Constructing relationship of trust

The relationship of trust between the project members and the promoters of knowledge management is necessary to promote leverage information and create a good atmosphere where project members open and share their own information. In order to construct the relationship, we have to collect users' requirements and opinions, and respond to them carefully and rapidly. For collecting users' ideas and opinions, we send some staff that support information management of projects, and ask them to interview users for their ideas and opinions. Additionally, we will assess the progress of leverage from the number of access results and download results. By analyzing users' operation logs, we will assess the effectiveness of the function of retrieval. We will feed back the improve points to the operation of STAR from these assessment results.

Through these activities, we hope a good atmosphere will be made on the relationship of trust.

(3) Encouragement

We will not only require users' leverage but also make users understand the objective and the merit of sharing information. We had some opportunities to explain our activity, but the spirit of sharing knowledge has not penetrated all project members yet. So it is important to keep encouraging the objective and merit of sharing information. This activity also will promote the usage of STAR and let project members open and share each other.

(4)Cross search

We are considering the search system which provides the function of searching across some information systems at the same time and the function of full-text search. By using this system, project members can retrieve technical information not only in the satellite office but also in the other departments like the failure information system, the test data management system and the parts database. We will develop a prototype system in 2007 for a feasibility study.

5.2 long-term

Pursuit of intuitive retrieval and Optimization of system architecture are required. In order to achieve them, three points which will be done for long-term are shown as follows.

(1) Various viewpoints

Each person has their own viewpoint to retrieve information. The retrieval function which provides a method to be able to support various viewpoints can improve retrieval performance remarkably. Six examples are shown as follows.

- The equipment structure of satellite.

Users can retrieve by selecting keywords from the tree of the equipment structure such as System, components, parts, and so on. It is assumed that the structure will be used in cases when users are looking for information related design drawings and CAD data.

- The function tree of satellite

Users can retrieve by selecting keywords from the tree of the function structure such as system, subsystem, function, and so on. It is assumed that the structure will be used in cases when users confirm the function requirements.

- Technical discipline

Users can retrieve by selecting keywords such as electrical, thermal, structure, communication, altitude control, and so on. These keywords are similar to the keywords of the subsystem. It is assumed that the structure will be used in cases when users consider elemental technical issues.

- Satellite type

Users can retrieve by selecting keywords such as earth observation, navigation and positioning, communication, orbit type (LEO, GEO, etc.), and so on. It is assumed that the structure will be used in cases when users narrow their search to a similar satellite.

- The task based structure tree

Users can retrieve by selecting keywords from the tree of the defined Work Breakdown Structure (WBS), task, State Of Work, and so on. It is assumed that the structure will be used in cases when users promote their business process according to the standard process of satellite development (ex. Test). For that, standard WBS and task including the definition of input and output documents are required.

- The document tree structure

Users can retrieve documents from the document tree structure. It is assumed that the structure will be used in cases when users are looking for clearly structured documents, such as planning documents and requirement documents.

In order to realize the retrieval of various viewpoints, these keywords have to be related to the information. For that, Standardized keywords are required. However, the heavy workload to relate many keywords to the information will prevent registration. The function of input support by IT and proper size of keywords are very important. One solution is “keywords displayed on a computer screen without scrolling”. (Masanori Takahashi, 2006） Additionally we have to consider how to visualize the various viewpoints.

(2)Relationship between information

Relationship between information which is required by a lot of project members is very important. However we have to consider how to deal with the workload to register this relation.

We think a function where the user can add relation to the information like “Trackback” is preferable. Of course the function needs to be easy to enter keywords. Because more expansive relation can be expected than the registering person alone, this function must be able to contribute the intuitive retrieval.

(3)Optimization of system architecture

EUC is good, but it requires a lot of workload and money for projects to get and operate their own server machine. It is meaningless if EUC prevent sharing information. After the effective standard rule is decided and a new process is getting into orbit, the whole architecture should become more efficient and reliable. However each office and department has a different culture, method and rule, so it might be difficult to integrate one system in JAXA. In the satellite office, at least PIMS should be integrated to one server.

As an image in the future, the two layer architecture (Fig. 4) which consists of an upper system and lower systems is preferable. Lower systems are the information management systems which have actual entity and optimized user interface with the office and department. Upper system is the indexing system which provides the cross search function to the users.

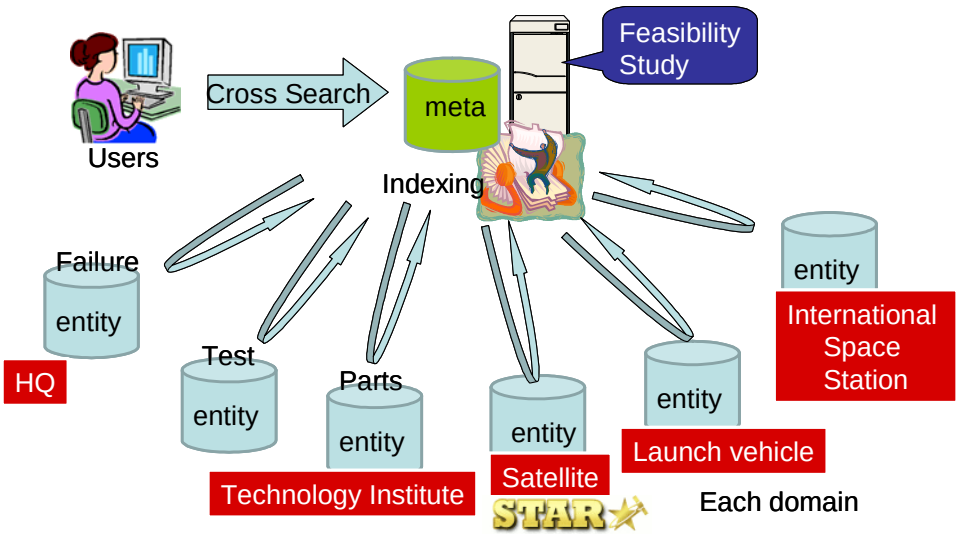

Fig.4 Long-term system architecture

6. CONCLUSION

In JAXA, the satellite office has been doing knowledge management activities due to the improvement of the reliability of satellite development. Previously we had two issues which are inadequate sharing information of other projects and the existence of the risk of losing technical information of the terminated projects. A new rule and new system is being applied to projects. As a result, especially issues for capture and storage are being improved.

However some issues to leverage technical information still remain. Especially the situation which cannot promote leverage because of "bad spiral" from lack of contents is a major issue.

As near-term future plan, by enriching contents and constructing a relationship of trust between users of STAR and the promoters of knowledge management, we will change the situation to a "good spiral". For our long-term future plan, we will pursue the most intuitive function to retrieve information and implement optimized architecture.

We believe these activities will contribute to the improvement and development of the reliability of the satellite.

Additionally we hope to create an environment where the right people can get technical knowledge freely and create new knowledge by using the right knowledge in JAXA.

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